

CHAPTER-28

POLICY FRAMEWORKS AND INSTITUTIONAL SUPPORT

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Abstract

Agricultural policy in developing economies has long relied on analog instruments such as income transfers, input subsidies, and credit support, mechanisms that address immediate farmer vulnerability but remain structurally ill-equipped to engage with the rapid digitization of agricultural systems. This chapter argues that the central barrier to inclusive digital agriculture is not the absence of technology but the absence of coherent policy frameworks capable of translating technological potential into tangible farmer benefit. Drawing on existing policy experiences, academic literature, and identified institutional gaps, the chapter proposes a three-layered policy framework spanning enablement, regulation, and governance. The enablement layer addresses financial and practical barriers to technology adoption through targeted subsidies, publicly funded AI advisory access, and digital promotion infrastructure. The regulatory layer establishes farmer data rights and platform interoperability standards to ensure that digital participation serves farmer interests rather than extracting value from them. The governance layer delineates institutional responsibilities across national and state governments, research institutions, and the private sector, while proposing a phased implementation roadmap with measurable farmer-centered indicators. The chapter concludes that transforming the smallholder farmer from a passive recipient of digital change into an empowered participant within the digital agricultural economy represents the defining governance challenge of the present agricultural transition.

Keywords: Digital agriculture, Policy frameworks, Agri-fintech, Data governance, Policy enablement

1. Introduction

The global agricultural sector stands at a critical inflection point. While digital technologies have fundamentally transformed industries ranging from finance to healthcare. However, agriculture the backbone of economies across the developing world, has been comparatively slow to absorb these changes at the policy level. Digital agriculture, broadly understood as the integration of data-driven technologies such as artificial intelligence, blockchain, precision farming tools, drones, and electronic market platforms into agricultural systems, holds significant promise for enhancing farmer productivity, market access, and income stability. Yet the central problem is not the absence

of technology, it is the absence of policy frameworks that can translate these technologies into tangible farmer benefit.

Existing agricultural policies across developing economies, including India, have historically prioritized income support, input subsidies, and credit access. While these interventions remain important, they are fundamentally analogue responses to what is increasingly a digital problem. Schemes such as PM-KISAN or the Minimum Support Price mechanism address the symptoms of farmer vulnerability but do not engage with the structural transformation that digitization makes possible. As Mhlanga and Ndhlovu (2023) argues, the limited focus on digital technology adoption in smallholder farming contexts carries serious policy implications, particularly when institutional frameworks fail to keep pace with technological change.

This gap is consequential. When farmers are excluded from digital value chains, the benefits of agricultural digitization accrue disproportionately to intermediaries, agri-tech corporations, and larger landholders. Smallholder farmers, despite their critical role in global food security, remain largely beyond the reach of digital solutions due to underdeveloped or non-existent digital ecosystems. The question, therefore, is not whether digital agriculture is desirable, that case has been made extensively, but rather what governments must specifically do, regulate, fund, and protect in order for digital agriculture to work in the farmer's interest.

This chapter addresses that question directly. It proposes a structured, three-layered policy framework, spanning enablement, regulation, and governance, designed to guide institutional action across the full spectrum of digital agriculture. The framework draws on existing policy experiences, emerging academic literature, and identified structural gaps to offer concrete, actionable recommendations for governments seeking to position agriculture for a digital economy. A visual roadmap of the chapter's structure is presented below, followed by a detailed examination of each policy layer in the sections that follow.

2. The Policy Gap in Digital Agriculture

Agricultural policy across developing economies has long been anchored in conventional instruments such as direct income transfers, input subsidies, and credit support. While these mechanisms address immediate farmer vulnerability, they do not engage with the structural transformation that digitization demands. Recent digital innovations provide opportunities to deliver better policies for the agriculture sector by helping to overcome information gaps and asymmetries, lower policy related transaction costs, and enable people with different preferences and incentives to work better together (OECD, 2019). Yet the potential identified in such assessments remains largely unrealised in practice, representing a fundamental design limitation rather than a resource problem.

The gap, therefore, is not merely financial, it is conceptual. Governments continue to frame farmer welfare in analogue terms while the agricultural economy increasingly operates through digital platforms, data systems, and algorithmic markets. The persistent disconnect between policy rhetoric and on-ground implementation highlights the urgent need for inclusive governance and participatory design in digital agricultural transitions. Without a dedicated policy framework oriented toward digital growth capacity, farmers risk being passive bystanders in a transformation that could otherwise work decisively in their favour.

A further dimension of this gap is the absence of trust building measures within existing policy design. Farmers across developing economies are increasingly exposed to digital platforms and

data collection practices without any corresponding policy protection or transparency guarantee. A key challenge for policymakers lies in finding a balance between protecting the privacy and confidentiality of agricultural data and farmers economic interests in that data, while making it possible to leverage their potential for the sector's growth and innovation. Current policy frameworks have largely failed to engage with this tension, leaving farmers in a position where digital participation carries unacknowledged risks that erode both trust and uptake.

Perhaps most critically, the policy gap reflects a deeper failure of imagination about what agricultural policy can and should do in a digital era. The dominant policy paradigm continues to treat technology as an external variable, something that markets will deliver and farmers will eventually adopt, rather than as a domain requiring active public governance. The digitalisation of agriculture raises a new generation of policy issues including questions around data governance, platform regulation, and the equitable distribution of productivity gains, issues that existing agricultural policy frameworks were simply not designed to address. Closing this gap requires not merely new schemes but a fundamentally new orientation in how governments conceive of their role in agricultural development.

3. Enablement Policies

The first and most immediate layer of a digital agriculture policy framework concerns enablement, which is the direct role of government in making digital tools financially and practically accessible to farmers. Technology, however transformative, remains irrelevant to a smallholder farmer if its cost is prohibitive or its availability limited to commercially well-endowed actors.

The most pressing enablement priority is the subsidization of precision agriculture technologies and drone systems. High initial costs, technical skill requirements, and limited rural connectivity remain the core barriers to precision agriculture adoption among smallholder farmers, and governments and agribusinesses are increasingly addressing these through subsidies, training programs, and public-private partnerships.

Beyond hardware, enablement must extend to knowledge infrastructure. Government-funded access to AI-based advisory tools, crop monitoring systems, and decision-support platforms for agricultural researchers, students, and extension workers is an equally critical intervention. The translation of AI's technical promise into equitable and scalable agricultural systems is increasingly bottlenecked by socio-technical and ethical challenges, pointing to the need for a deliberate governance shift from techno-optimism to structured institutional support. Publicly sponsored access to these tools within agricultural universities and Krishi Vigyan Kendras would ensure that the research and advisory ecosystem keeps pace with technological advancement.

A third and largely overlooked enablement priority concerns agri-tourism and digital promotion. Farmers engaged in agri-tourism, organic production, or region-specific crafts possess a compelling story that digital platforms can monetize, yet most lack the skills or institutional guidance to do so. Government-established digital hubs at the block or panchayat level, specifically designed to train farmers in using social media platforms for income generation and brand building, would represent a genuinely novel policy intervention with measurable income impact potential.

Taken together, these enablement measures technology subsidies, AI access for research, and digital promotion support, form the foundational layer upon which more complex regulatory and governance frameworks must rest.

4. Market Access and Digital Finance Policies

Access to markets and access to finance are two of the most persistent structural constraints facing smallholder farmers, and digital policy has a decisive role to play in addressing both simultaneously. While technology alone cannot resolve these constraints, targeted institutional intervention can transform the conditions under which farmers participate in agricultural markets.

India's electronic National Agriculture Market, commonly known as e-NAM, represents the most significant existing institutional experiment in digital market access. Launched in 2016, the platform networks existing Agriculture Produce Market Committee mandis into a unified national trading portal, enabling transparent price discovery and direct digital payments to farmer bank accounts. While e-NAM marks a significant shift toward digital agriculture and market modernisation, its success depends on comprehensive reforms in market operations, digital infrastructure, and stakeholder engagement, with infrastructural, regulatory, and digital literacy barriers continuing to constrain its full-scale adoption, particularly among smallholder farmers (Pawar and Walke, 2024). Policy, therefore, must not merely expand the reach of e-NAM but must address these structural bottlenecks directly through complementary investments in rural connectivity, farmer onboarding support, and APMC reform.

Beyond market access, the digitisation of government procurement processes represents an equally important frontier. The Minimum Support Price procurement mechanism, which remains central to farmer income security, continues to operate largely through manual, intermediary-dependent channels that are vulnerable to leakage and delayed payments. Integrating procurement pipelines with blockchain technology would create an immutable, transparent record of each transaction, ensure direct and timely payment to farmers, and generate a formal digital transaction history for every participating farmer. Blockchain technology offers a transparent and traceable supply chain architecture that fundamentally removes the need for intermediaries, with findings indicating strong promise for food supply chain reform despite the persistence of technical, educational, and regulatory barriers that currently hinder wider adoption (Kamilaris *et al.*, 2019).

This digital transaction record carries a further and underappreciated economic implication. Currently, the majority of smallholder farmers remain outside the formal credit system because they lack the documentation and financial history that lending institutions require. A farmer's verified record of digital market transactions, yield data, and procurement history can serve as a form of alternative collateral, enabling agri-fintech institutions to extend credit on the basis of a farmer's digital footprint rather than solely on land ownership or prior credit scores. Policy must create the regulatory conditions for this to occur, including through formal recognition of agricultural digital records as valid financial documentation and through the establishment of credit guarantee mechanisms for fintech institutions lending to digitally active farmers.

Taken together, the reform of digital market platforms, the digitisation of public procurement, and the development of agri-fintech policy constitute a coherent and mutually reinforcing set of market access interventions that can significantly alter the economic position of the smallholder farmer within the agricultural value chain.

5. Regulatory Policies

Enablement policies create access, but without a parallel regulatory framework, digital agriculture risks deepening the very inequalities it promises to resolve. Regulation in this context does not mean restriction, it means establishing the rules of a fair digital agricultural economy.

The most urgent regulatory priority is farmer data rights. When a farmer uses a digital platform, whether for market access, crop advisory, or input procurement, he generates valuable data on his soil health, yield patterns, cropping cycles, and market behaviour. Under current arrangements, this data is owned and monetised by the platform rather than the farmer who produced it. The ambiguity around who owns agricultural data, who has rights over it, and whether regulation is needed has created conditions of data lock-in, data fragmentation, and a fundamental lack of trust among farmers toward digital service providers (Atik, 2022). Governments must enact clear legislative frameworks that recognise farmers as the primary rights holders over data generated on their land and through their productive activity.

A closely related regulatory imperative concerns platform accountability and interoperability. As the agri-tech market expands, farmers increasingly find themselves locked into proprietary platforms with no ability to transfer their data elsewhere. Farmers are the creators of agricultural data while companies collect and analysts decide how it is used and who accesses it, with farmers effectively positioned as customers paying for services built on their own information (Ibrahim and Trugly, 2023). Policy must mandate open standards for agricultural data portability, ensuring that a farmer's digital record is his to carry across platforms, much as the Unified Payments Interface established interoperability across India's financial payment ecosystem.

Together, data rights legislation and interoperability standards form the regulatory spine of a fair digital agriculture economy, without which enablement investments will continue to benefit platforms more than the farmers they claim to serve.

6. Infrastructure Policies

Digital agriculture cannot function without digital infrastructure, and the most fundamental infrastructure gap in rural economies is connectivity. A policy framework that invests in drones, AI tools, and blockchain platforms while leaving rural broadband unaddressed is structurally incomplete. Connectivity must be treated not as a telecom policy question but as an agricultural policy priority. Rural broadband provides the essential network infrastructure that precision agriculture and smart farming technologies require making it extremely necessary to provide farmers with broadband internet facilities. Governments must accordingly classify rural broadband investment within agricultural infrastructure budgets, alongside irrigation and rural roads, rather than leaving it entirely to market-driven telecom expansion.

The second infrastructure priority concerns digital extension services. Traditional agricultural extension systems, delivered through Krishi Vigyan Kendras and field officers, are chronically under-resourced relative to the farmer populations they serve. Digital platforms offer a scalable and cost-effective alternative. A key recommendation for policy development in agricultural advisory services is to establish a clear legal mandate for digital extension services, emphasising the importance of unifying management units and establishing digital extension centres to provide quality, informative, and truthful advisory at scale (Sen *et al.*, 2025). Government investment in regional language chatbots, WhatsApp based advisory groups, and AI assisted crop guidance platforms, developed in partnership with agricultural universities and managed through a national digital extension mandate, would significantly extend the reach of public agricultural knowledge without proportionally increasing administrative costs.

7. Institutional Architecture: Who Does What?

A policy framework, however well designed, is only as effective as the institutional machinery responsible for implementing it. Digital agriculture in particular demands a clear and coordinated division of responsibilities across government levels, research institutions, and the private sector, because its interventions span technology, regulation, markets, and extension simultaneously.

At the national level, the central government carries the primary responsibility for setting standards, financing infrastructure, enacting data rights legislation, and coordinating cross-sectoral digital agriculture strategy. State governments, given their constitutional authority over agriculture in India, must serve as the implementation layer, adapting national frameworks to local crop ecologies, languages, and market structures. The current fragmentation of institutional management, evident even within existing structures, poses a serious coordination risk. The decentralised institutional management of Krishi Vigyan Kendras across multiple administrative jurisdictions including state governments, agricultural universities, ICAR institutes, and NGOs makes coordination more difficult, dilutes accountability, and impedes the crafting of a unified national extension strategy (Salunke, 2025). A dedicated national digital agriculture coordination council, with state level units operating under its mandate, would address this fragmentation directly.

ICAR and State Agricultural Universities must be repositioned not merely as research institutions but as active nodes in the digital agriculture delivery system, responsible for developing regionally relevant AI tools, validating digital advisory content, and training the next generation of agri-tech extension professionals. Private sector actors and agri-tech startups, meanwhile, must be brought into a regulated partnership model rather than left to operate outside public accountability structures. Public private partnership models in agricultural extension, including initiatives such as ITC's e-Choupal and collaborations under ATMA and Krishi Vigyan Kendras, illustrate how partnerships between government and private actors can enhance farmer outreach, boost productivity, and deliver context specific advisories through both digital and physical channels (Rana *et al.*, 2025). Formalising and scaling such models through clear regulatory agreements, performance metrics, and equity safeguards would ensure that private sector innovation serves public agricultural goals rather than displacing them.

8. Implementation Roadmap

A policy framework without a sequenced implementation plan risks remaining aspirational. The translation of digital agriculture policy into on-ground outcomes requires a phased approach that distinguishes between what can be done immediately, what must be built over the medium term, and what constitutes the long-term structural transformation being pursued. Leading frameworks for digital agriculture implementation recommend a phased approach that identifies near-term quick win initiatives aligned with political decision-making cycles alongside longer-term initiatives that strengthen the broader ecosystem, with a phased structure ensuring successful early adoption while laying the groundwork for transformative change over time (World Bank, 2025).

In the short term, covering roughly the first two years, government action should prioritise interventions that are politically feasible, institutionally straightforward, and capable of demonstrating visible farmer benefit quickly. These include launching drone and precision agriculture subsidy pilots in selected districts, expanding e-NAM onboarding with dedicated digital literacy support, establishing the first round of block level digital hubs for agri-tourism and social media promotion, and initiating the legislative process for a farmer data rights framework.

In the medium term, spanning years two through five, the focus should shift toward building the infrastructure and regulatory architecture that the short-term pilots depend on. This includes operationalising rural broadband as agricultural infrastructure under national budget classifications, rolling out blockchain-based procurement pilots under the MSP mechanism, establishing a national digital extension mandate with regional language advisory platforms, and formalising public-private partnership agreements with agri-tech firms under a regulated accountability framework.

The long-term horizon, from year five onward, envisions a fully integrated digital agriculture economy in which a farmer's production, market transactions, credit history, and advisory interactions exist within a single interoperable data ecosystem. Effective monitoring of implementation requires a well-designed results framework that tracks progress at both the initiative level and the overall strategy level, with key performance indicators reflecting not merely technology uptake but actual improvements in farmer outcomes (World Bank, 2025). Indicators such as percentage of smallholder farmers with active digital market accounts, average income change among digitally active farmers, and volume of agricultural credit extended on the basis of digital records would together provide a meaningful measure of whether the framework is achieving its intended purpose.

9. Challenges and Risks

No policy framework is complete without an honest account of the obstacles it faces. Digital agriculture policy operates in a complex environment shaped by structural inequalities, institutional inertia, and genuine risks that must be acknowledged and planned for rather than minimised.

The most fundamental challenge is the digital divide. Access to digital tools is not evenly distributed, and the farmers who stand to benefit most from digital agriculture interventions, namely smallholders in remote and economically marginalised regions, are precisely those least likely to have the connectivity, literacy, or devices required to participate. Policy must therefore incorporate explicit equity safeguards, including targeted outreach to women farmers, elderly cultivators, and farmers in low-connectivity regions, rather than assuming that access will trickle down through market forces alone.

The second major risk concerns data sovereignty. As government and private platforms accumulate increasing volumes of farmer data, the potential for misuse, surveillance, or commercially exploitative profiling grows correspondingly. Technologies need to be able to interrelate with the social practices of the communities they serve, and scholars have called for cautious deliberation of the challenges that digital technologies could trigger in already vulnerable communities such as rural farmers (Mhlanga and Ndhlovu, 2023). A policy framework that enables data collection without simultaneously enacting strong data protection legislation creates conditions for harm that could erode farmer trust in the entire digital agriculture project.

Third, intermediary resistance represents a structural political risk. Agricultural middlemen, commission agents, and traders who currently profit from information asymmetries between farmers and markets have a direct material interest in preventing the transparency that digital systems would bring. Any policy that meaningfully reforms market access or procurement digitisation will encounter organised resistance from these actors, and governments must anticipate this through coalition building with farmer organisations and consumer groups.

Finally, the financial sustainability of digital agriculture schemes poses a long-term governance challenge. Subsidy programmes for drones, precision tools, and digital hubs require sustained budgetary commitment across successive political cycles, and the history of agricultural policy in developing economies is replete with schemes that were launched with ambition and abandoned with indifference. Embedding digital agriculture targets within multi-year fiscal frameworks and subjecting them to independent performance review would reduce this risk considerably.

10. Conclusion

Agriculture stands at a moment of genuine transformation, and the central argument of this chapter has been that technology alone will not deliver that transformation to the farmer. What is required is deliberate, structured, and equitable policy architecture that places the smallholder farmer not as a passive recipient of digital change but as an active and empowered participant within it.

The framework presented across the preceding sections rests on three mutually reinforcing layers. Enablement policies ensure that the tools of digital agriculture, whether drones, precision technologies, AI advisory systems, or digital promotion platforms, are financially accessible and institutionally supported for farmers who would otherwise be excluded by cost or geography. Regulatory policies ensure that as farmers engage with digital systems, their data, their market rights, and their economic interests are protected by law rather than left to the discretion of platform providers. Governance policies ensure that the institutional machinery responsible for delivering this framework is coordinated, accountable, and capable of sustaining commitment across political cycles.

What distinguishes this framework from conventional agricultural policy is its orientation. Rather than asking how government can support farmers within an existing economic structure, it asks how government can help farmers grow through and within a new digital economic structure. This is a meaningful distinction. Income transfers and input subsidies address present vulnerability. Digital agriculture policy, when properly designed, addresses future capacity. Both are necessary, but the latter has been systematically neglected in policy discourse and budgetary priority.

It is also worth recognising that the framework proposed here is not a distant or speculative ambition. The building blocks already exist in various forms across different contexts. Electronic market platforms, drone subsidy pilots, blockchain procurement experiments, and agri-fintech innovations are all operational in some measure. What is absent is not the evidence of possibility but the political and institutional coherence to bring these fragments together into a unified, farmer-centred policy system. The work of policymaking in digital agriculture is therefore less about invention and more about integration, less about creating something entirely new and more about governing what already exists with greater deliberateness and equity.

The challenges are real. The digital divide, data sovereignty risks, intermediary resistance, and fiscal sustainability are not minor implementation details but structural political and economic problems that will require sustained political will to navigate. Acknowledging these challenges is not a concession to pessimism but a prerequisite for designing policy that is honest about what it is attempting and realistic about what it will take.

It is equally important to acknowledge that digital agriculture policy cannot succeed in isolation from broader rural development priorities. Connectivity without literacy, platforms without regulation, and technology without institutional support are each insufficient on their own. The framework advanced in this chapter is premised on the understanding that digital transformation

in agriculture is a whole-of-government challenge, one that requires coordination across ministries of agriculture, finance, telecommunications, education, and law. Countries that treat digital agriculture as a narrow sectoral concern rather than a cross-cutting governance priority will find that their interventions, however well intentioned, fall short of the systemic change that the moment demands.

The vision at the end of this framework is a farmer who does not merely produce food but who markets it, finances it, traces it, and owns his role within the value chain it travels through. That farmer exists today in fragments, in isolated pilots, in individual success stories that have not yet become systemic outcomes. The task of policy is to make that farmer the norm rather than the exception, and the framework proposed in this chapter is offered as a contribution toward that necessary and overdue ambition.

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